

NATIONAL AIR INTELLIGENCE CENTER



THE ROAD TO DEVELOPING A CHARACTERISTICALLY
CHINESE GROUND TO AIR MISSILE

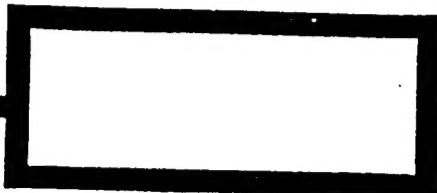
by

Ai Jiyu



19960715 059

Approved for public release:
distribution unlimited



HUMAN TRANSLATION

NAIC-ID(RS)T-0096-96 20 May 1996

MICROFICHE NR: *96C000462*

THE ROAD TO DEVELOPING A CHARACTERISTICALLY
CHINESE GROUND TO AIR MISSILE

By: Ai Jiyu

English pages: 13

Source: Cama, China Astronautics and Missilery Abstracts,
Vol. 2, Nr. 4, 1995; pp. 36-43

Country of origin: China

Translated by: SCITRAN

F33657-84-D-0165

Requester: NAIC/TASC/Richard A. Peden, Jr.

Approved for public release: distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL
FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITO-
RIAL COMMENT STATEMENTS OR THEORIES ADVOC-
ATED OR IMPLIED ARE THOSE OF THE SOURCE AND
DO NOT NECESSARILY REFLECT THE POSITION OR
OPINION OF THE NATIONAL AIR INTELLIGENCE CENTER.

PREPARED BY:

TRANSLATION SERVICES
NATIONAL AIR INTELLIGENCE CENTER
WPAFB, OHIO

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

ABSTRACT This article sets out from the role of ground to air missiles in the air defense of national territory and the operational environment of ground to air missiles in future wars and discusses the development of China's ground to air missiles from now on, pointing out the road that should be traveled in the development of a characteristically Chinese ground to air missile--striving to speed up the development of Chinese ground to air missile weapons systems.

KEY WORDS Ground to air missile Role Environment
Development

1 The Role of Air to Ground Missiles in the Air Defense of National Territory

The ground to air missiles are the most basic active ground to air weapon. They are an important constituent part of modern air defense weapons systems. They are the backbone of their strength. In modern air defense systems, they occupy an irreplaceable position. Air defense weapons include fighter aircraft, ground (ship) to air missiles, antiaircraft artillery, as well as directed energy weapons, and so on. Comparing ground to air missiles with fighter aircraft, they are capable of maintaining high states of combat readiness; their reactions are fast; fire power is fierce;

might is great; kill and damage probabilities are high; they are capable of handling high speed maneuvering targets. In particular, in the area of handling air to ground missiles, cruise missiles, and tactical ballistic missiles, fighter aircraft cannot see their dust. Comparing air to ground missiles with antiaircraft artillery, kill and damage probabilities are high; combat air sectors are large; reliability is high. Comparing ground to air missiles with directed energy weapons, technology is mature; they can be installed in large numbers. Although directed energy weapons have certain advantages, they are, however, still under development. Around the year 2000, it may be possible to equip in small numbers--far, far from being able to satisfy the requirements for beating back air raids on a large scale. It can be seen that ground to air missiles, fighter aircraft, and antiaircraft artillery will still be the basic air defense weapons around the year 2000. Ground to air missiles are indispensable key air defense interception weapons. As a result, foreign militaries believe that, among interception weapons, "ground to air missiles are the foundation for the structuring of air defense firepower." Various nations of the world pay very serious attention to ground to air missile development and deployment. From the Second World War until now--although it has only been a very, very short something over forty years--foreign militaries, however, have already equipped themselves with as many as over forty types of ground to air missiles--varieties are complete and models are varied. At the present time, there are already close to twenty nations in the world that are capable of autonomously designing and manufacturing ground to air missiles. Moreover, there are over seventy nations equipped with this type of weapon. Overall, production of various models of ground to air missiles is close to four hundred thousand units.

Ground to air missiles play a decisive role in actual combat. Ground to air missiles were introduced to the world in the 1940's. They have been introduced into real combat since the 1960's. They have already been made use of multiple times in air defense of national territory and during limited wars, playing important roles in all cases and creating illustrious results. For example, North Vietnamese ground to air missile units--in concert with air defense

artillery--achieved combat results associated with the downing of over 1400 U.S. aircraft. From 18-30 December 1972 alone, when U.S. forces launched B-52 bombers to carry out carpet bombing of North Vietnam, 32 planes were shot down by the North Vietnamese. Among these, ground to air missile shoot downs accounted for 29 planes--91%--playing a key role in forcing the U.S. to peace talks and withdrawal of forces. In 1974, in the fourth Middle East War, /37 the Israeli's lost 114 planes. Among these, 62% were shot down by ground to air missiles, destroying the myth of the invincible Israeli air force. In 1982, during the British-Argentine island war, the British destroyed a total of 105 Argentine aircraft. Among these, 31 were shot down in aerial combat. 30 were destroyed on the ground. Warship guns shot down 7 aircraft. 37 planes were shot down by ground to air missiles. During the 1991 Gulf War, "Patriot" ground to air missiles successfully intercepted "Fleet Footed Runner (SCUD)" tactical ballistic missiles. Iraq launched a total of 98 "Fleet Footed Runner (SCUD)" missiles. The "Patriot" rate of successful intercept reached over 80%, opening a new era of ground to air missiles intercepting tactical ballistic missiles in actual combat and destroying the myth of "the uninterceptable tactical ballistic missile". For maintaining a calm mood among threatened populations, for maintaining the alliance of multinational units, and for achieving victory in this war within 42 days, this played quite a large role in all cases. On 7 October 1959, in the Beijing area, Chinese ground to air missile units shot down for the first time a KMT air force high altitude reconnaissance plane. This was also the first time in the history of world air defense that use was made of ground to air missiles to shoot down aircraft. From 1959 to 1987, China altogether shot down X X intruding aircraft of various types. Basically, they were all shot down by ground to air missiles. This greatly boosted national power and military might, resolutely striking at the bloated arrogance of the KMT who did not dare to intrude again.

In future air defense warfare, ground to air missiles will play an even greater role. Although world trends move toward detente, possibilities, however, still exist for the outbreak of wars. According to predictions, around the year 2000 "will be an era of protracted total warfare". Air raids and air defense battles will develop to a new stage. Recently--particularly, after the Gulf War--various nations of the world, one after the other, adjusted their national defense arrangements. Air defense was the focus of their priority developments. New plans were made for air defense systems--in particular, ground to air missile development. Looking at development trends, ground to air missiles will be the main force dealing with various types of aircraft and tactical ballistic missiles. From now on, their position will also obtain obvious strengthening. From the Gulf War, it can be seen that offensive combat against aviation troops will certainly not be able to substitute for limited missile defenses. The great air power of multinational units was definitely not able to eliminate Iraq's missile threat. Moreover, the "Patriot" success at intercepting "Fleet Footed Runner (SCUD)"'s, is explained by ground to air

missiles possessing missile defense capabilities--having particularly important political and strategic importance in wars.

Summarizing what is discussed above, it is possible to see that ground to air missiles hold a key position among modern air defense systems--the backbone of their power. As far as changes in the international situation are concerned--particularly, the Gulf War--they have produced profound influences on the development of ground to air missiles. They will necessarily play a larger and larger role.

2. The Combat Environment of Ground to Air Missiles in Future Wars

From the experiences associated with limited wars as well as trends in the development of new technologies, it is possible to see that the combat environments which ground to air missiles will be placed in during future wars will be very complicated and very rigorous. This is because--in wars of the future--there will be comprehensive utilization of various types of air raid weapons. Option is made for the use of such measures as all around, multiple altitude, night time defense penetration, saturation tactics, stealth technology, electronic jamming, and so on. This will make aerial defense penetration capabilities rise to a new level. The main characteristics are:

2.1 Proliferation of Types of Air Raid Weapons and Improved Performance. Air Attack Means Opting for the Use of Multiple Types of Long Range Precision Guided Weapons Attacks.

Weapons associated with the execution of air raids include various types of aircraft and missiles. The performance of a new generation of aircraft for carrying out air raids has rapidly improved. Development cycles have been greatly shortened. These new types of aircraft (including various types of bombers, fighters, attack planes, armed helicopters, and reconnaissance planes) not only possess high altitude, high speed, high maneuverability performance. They are, moreover, equipped with advanced electronic equipment, making flight control and fire control systems realize automatization. They possess look down shoot down capabilities, and they have capabilities for all weather combat and defense penetration at different altitudes. At the same time, due to rapid development of air defense weapons--in particular, ground to air missiles--air raid means will tend away from the close air attacks and bombing the use of which was normally opted for in the past and toward opting for the use of multiple types of guided weapons to attack from long range--not only very, very greatly increasing hit precision, but lowering aircraft loss rates. Modern combat aircraft are generally capable of carrying precision guided weapons with relatively long ranges in all cases--for example, air to ground missiles, cruise missiles, antiradiation missiles, guided bombs, and so on. The speed of development of these precision guided weapons, unceasing improvements in performance, and widespread use will doubly improve air raid results. According to estimates, the combat capabilities

of one aircraft carrying guided bombs and air to ground missiles is equivalent to 20-40 aircraft carrying ordinary bombs. According to U.S. Air Force estimates, during the Gulf War, hit rates of U.S. Air Force missiles and guided bombs were above 80%. Hit rates of conventional bombs, however, are not even 30%. The hit accuracy of the "Tomahawk" cruise missile of U.S. forces is 10 meters. Attack efficiencies are above 90%. Their power can destroy a reinforced concrete building. Missiles and precision guided weapons of multinational units put Iraq at a loss what to do. As a result, it is possible to believe that Iraqi forces were primarily bombed out of existence by missiles and precision guided weapons. As far as the use of tactical ballistic missiles in limited wars is concerned, their key position and role in modern warfare was displayed--drawing the attention of the world. After the Second World War, there were three limited wars where use was made of tactical ballistic missiles. In the 68-73 Middle East wars, Egypt and Syria launched 28 "FROG" and "Fleet Footed Runner (SCUD)" missiles at Israel's hinterland, destroying an armored brigade of the Israeli forces. In the 81-88 Iran-Iraq war, both sides launched a total of 632 "Fleet Footed Runner (SCUD)" missiles. In 52 days from February to April 1988--during the "battle to wipe out the cities"--Iraq launched 189 missiles against Tehran, causing heavy Iranian casualties. Iraq realized the objective of "seeking peace with a bomb". During the 91 Gulf War, in a situation where Iraq had totally lost air superiority, 98 "Fleet Footed Runner (SCUD)" missiles were launched at Saudi Arabia and Israel. They became the only means of making large scale air attacks on the enemy rear area--having a certain restricting, threatening, and destructive effect. From the above, it can be seen that--in modern limited wars--making use of conventional warheads and tactical ballistic missiles is already a tide which cannot be turned back. This is because--in modern warfare--tactical ballistic missiles possess a special place and role--ranges are long; speeds are fast; defense penetration capabilities are strong; defense is difficult. There is a deterrent power associated with attacking key points in depth. They are an important means of psychological warfare. At the same time, tactical ballistic missiles are also capable of carrying nuclear, biological, and chemical warheads. Their roles will be even greater. As a result, tactical ballistic missiles have given rise to extremely great attention in various nations of the world. In future wars, tactical ballistic missiles could very possibly become one of the key attack weapons. At the present time, approximately 15 nations in the world are equipped with ballistic missiles. It is estimated that, by the year 2000, this will expand to 24 nations. This is an extremely great threat with regard to air defense systems. As a result, after the Gulf War--one after the other--quite a few nations turned their hands to improving currently existing air defense systems, making them not only capable of opposing aircraft but also able to counter tactical ballistic missiles. At the same time, great efforts were put into the development of tactical antimissile weapons systems.

2.2 Saturation Attack

Combined utilization of various types of air attack weapons--carrying out continuous saturation attacks from different angles, different altitudes, on different scales, and in large bunches to suppress and destroy ground air defense weapons--has already become one type of key air attack operations form. On 9 June 1982, close to one hundred aircraft were sent out twice to carry out saturation attacks on missile battalions in the Bekka valley sector. Only 6 minutes were used and 19 SA-6 missile battalions were completely destroyed. The Gulf War lasted 42 days, friendly units sent out close to 110 thousand sorties of aircraft. An average of over 2500 sorties were sent out per day. On average, each day over 2000 /39

tons of ordnance was dropped. Without doubt, this is the greatest density of aircraft participating in combat in history. Air raid activities associated with extremely strong attacking firepower completely monopolized Iraqi air supremacy, putting her into a position of passively taking a beating, making Iraqi military organizations severely paralyzed. In conjunction with this, over 50% of Iraqi front line units were destroyed. It is possible to predict that future air attacks will become more and more violent.

2.3 Multiple Altitude, Omnidirectional Night Time Defense Penetrations

Defense penetration means associated with air attack weapons change along with the development of air defense weapons and aviation technology. Aviation troops in the 1950's normally opted for the use of medium or high altitude daylight defense penetrations in one certain direction. In the 1960's, due to the development of medium and high altitude air defense missiles, aviation troops generally changed to the use of low altitude or super low altitude defense penetrations in order to avoid radar reconnaissance and air defense missile attacks. After the 1970's, due to the development of medium and low altitude ground to air missiles and improvements in the performance of aviation weapons, aviation troops--at the same time as they took low altitude defense penetrations to be the main thing--began to pay serious attention to medium and high altitude omnidirectional night time defense penetrations. Moreover, high altitude night time defense penetrations represent an increasing trend. For example, in 1986, the U.S. forces conducted an air attack on Libya. In 1989, U.S. forces invaded Panama. Both were night time penetration raids on targets from different altitudes. Again, for example, during the Gulf War, multinational units had a good number of aircraft opt for the use of high altitude defense penetrations. Moreover, the aircraft loss rates were lower than for low altitude defense penetrations. Because night combat is advantageous for stealth and advantageous for the realization of surprise, it will become a key opportunity for combat. During the Gulf War, multinational units made use of advanced night fighting equipment as a means of night combat which was made widespread use of. During the 42 days of the war, 41 days all opted for the use of night combat--achieving very good combat results. This was also the first time in the history of warfare. Multiple altitude omnidirectional night time defense

penetrations gave air defense systems very great difficulties in increasing numbers.

2.4 Intense Electronic Jamming

Electronic jamming not only accompanies and covers other air attack weapons to carry out air raids. Moreover, electronic warfare itself is nothing else than one form of countering air attack against air attack and defense penetration against defense penetration. It has already become the fourth dimension of warfare. Looking from the point of view of several limited wars in recent years--for example, the Bekka valley combat, the Falklands war, and the Gulf War--all used electronic warfare as a precursor and to permeate the wars from beginning to end. It is a prevailing situation in warfare. In particular, the Gulf War manifested that even more clearly and prominently. Multinational units had many electronic warfare means. There is no way to compare the large scale of them to wars in the past. Therefore, Iraqi communications were cut, radar was blinded, command malfunctioned, the entire air defense system was placed in a state of paralysis, combat capabilities were lost, and they fell completely into the position of passively taking a beating. There was no option made for the use of effective counter reconnaissance and counter jamming methods. This was one of the primary causes that led to the crushing defeat. In electronic warfare, ground to air missiles conduct combat operations under conditions of concentrated, complex, and varied information, and various types of strong jamming. If one is looking to achieve success, it is necessary to have strong electronic countermeasures. The development of electronic jamming modes is many types of jamming methods. It is certainly not the ceaseless expansion of frequency ranges. It is predicted that, by the year 2000, there will be an unfolding struggle. Such realms as infrared and laser will also intensify countermeasures. From this, it can be seen that reconnaissance and counterreconnaissance, jamming and counter jamming, are extremely important in modern warfare. No matter how good weapons or equipment are, if they do not have electronic countermeasure capabilities, it is not possible for them to bring their roles into play in any case. They are not only important means of struggle in today's wars but also in future warfare. They are key factors relating to the success or failure of air attacks and countering air attacks. At a certain level, it is possible to say that it is a decisive factor.

2.5 Widespread Option for the Use of Stealth Technology

Beginning from the 1970's, a number of nations--one after the other--developed stealth technology. By the early 1980's, the technology was already experiencing breakthrough progress. The U.S., first of all, developed such stealth aircraft as the F-117A, and so on. The U.K, France, Japan, Russia, etc., also strengthened their development. It is predicted that, after the 1990's, a /40

new generation of military aircraft will make widespread option for the use of stealth technology. By the year 2000, stealth technology will also achieve further development--being applied not

only to fighter aircraft, strategic bombers, and cruise missiles, but also applied to such other air attack weapons as air to ground missiles, armed helicopters, and so on. As far as air raid weapons after option for the use of stealth technology are concerned, detectability is reduced. It is possible to cause radar reflective surfaces to diminish two orders of magnitude. By the year 2000, stealth results are predicted to be the radar reflective surfaces of fighter aircraft reaching 0.01 square meters, bombers 0.1 square meters, and air to ground missiles 0.04 square meters. Stealth weapons carry with them extremely great threats to air defense systems. The current air defense radars and air defense missile weapons systems of various nations have difficulty in all cases in detecting, tracking, and guiding missile attacks on stealth aircraft.

In 1989, when the U.S. invaded Panama, it made the first use of F-117A fighter bombers. In 1991, during the Gulf War, it again used them to bear the brunt, verifying that the stealth effects are good. During the Gulf War, a total of 127 F-117A stealth fighter bomber sorties were sent out. None of them were discovered by hostile radar. All returned safely.

Besides this, infrared stealth technology, optical stealth technology, and acoustic stealth technology are also under development.

2.6 Diversification and Synthesis of Tactical Applications

Future air attacks--besides close air air raids--will make primary use of various types of medium and long range missiles as well as cruise missiles to attack deep strategic targets. High, medium, and low altitude defense penetrations are made use of simultaneously or alternately. Coordinated use is made of various types of surprise attack weapons. The scales of surprise attacks are diversified. Electronic reconnaissance, jamming, and integrated destruction cause electronic warfare and air defense battles to be mixed into one entity. In summary, future tactical applications of air raids will be more diversified and integrated. It is necessary to make the suddenness, strength, and effects of air raids rise to a new level.

3. Prospects for Chinese Ground to Air Missiles

Ground to air missiles are the backbone of the strength of air defense systems. Moreover, in the wars of the future, they will be placed in combat under very rigorous conditions. Taking the long view of the reality of Chinese ground to air missile weapons systems at the present time, how should ground to air missiles be developed to make them capable of adapting to the requirements of future wars? In order to thoroughly put into practice military strategic guidance for the new era from the military committee--winning limited wars under the conditions associated with modern high technology--the development of Chinese ground to air missiles should travel the road associated with the development of ground to air missiles with Chinese characteristics. They should possess two special features. One is to combine with each other our

requirements with regard to ground to air missile weapons systems (should possess advanced characteristics) and what is possible (China's actual situation--technological status and economic base).

The second is--at the same time as striving to develop new models--pay very serious attention to the improvement of old models. Fight--by early in the next century--to take China's ground to air missile weapons systems and build them into sets of complete air sector air defense systems capable of adapting to the requirements of defending the air.

First of all, we take a look at the course of development of ground to air missiles in such places as the U.S., Russia, Western Europe, and so on, to possibly act as sources we can borrow from.

The economic strength of the U.S. is abundant. Science and technology are advanced. However, manpower expenditures and costs are high. As a result, by the middle 1960's--after several complete sets of various models of ground to air missiles--the focal point of development was put on full air sector multiple function ground to air missile systems. In "Patriot", the object is to achieve a position of technological superiority as well as reducing weapons system operation and maintenance personnel, thus lowering weapons system utilization costs.

The former Soviet Union adopted a policy of steady and sure advance, in sequence, step by step--developing various individual model types associated with different air sectors and different characteristics, taking multiple types of models and forming them into full air sector fire power. However, they did not go out to pursue multiple functions and full air sectors in a single system.

As far as the nations of Western Europe (except the U.K.) are concerned, the focus has been on the development of low altitude, short range, portable missiles. Medium and high altitude defense, by contrast, is primarily dependent on U.S. models. As far as these nations are concerned--due to their economic power being unable to match that of the U.S. and the strength of the Soviets--they usually adopted the road of cooperative development as a result.

China's situation is different from the U.S., the Soviets, and the various nations of Western Europe. The development path for ground to air missiles must start out from China's actual situation. The experience of other nations can act as material to borrow from. Before doing concrete analysis of China's development from now on, we will first revisit a bit the path of ground to air missile development which China has already traveled.

With the loving solicitude of the Party and the Nation, Chinese ground to air missile weapons systems have come into existence from nothing and grown from small to great. Coming up to the present time, preliminary formation is taking place of complete sets of air sector ground air defense systems. For more than thirty years, ground to air missiles have gone from introduction from the outside, the manufacturing of imitations, and improvements to the development of multiple models by the three land, sea, and air services. As far as the basic formation of several types of

air defense missile weapons systems is concerned, they form a full air sector air defense network capable of covering the operational altitudes that current air attack weapons are able to reach. Speaking in general terms, these missiles--due to the fact that their counter jamming capabilities are weak, maneuverability is bad, and tactical and technical performance is low--are not able, for these reasons, to satisfy the requirements of future air defense combat. During the process of development, we have also gone through a number of twists and turns. Primary among them was the 1960's. Due to interference associated with the thought of the extreme left--after falling behind technologically--we were still in a situation where basic research was not carried out. We pursued advances in the development of weapons systems unilaterally. It was finally difficult to avoid failing. This is a lesson which we should absorb. In that case--in the next ten years or more--how should China's ground to air missile weapons systems develop?

In order to thoroughly implement military strategic guidance from the central military committee relating to the new era, efforts should be made to speed up China's ground to air missile development. We should struggle--by early in the next century--to take China's ground to air missile weapons systems and set up complete air sector sets of integrated air defense systems capable of adapting to the needs of defending the air.

3.1 Strive to Develop Advanced New Models of Ground to Air Missile Weapons Systems Suitable to the Chinese National Situation

The development of new models of ground to air missiles should obey the fundamental principles set out below. First, with a view to being able to adapt to aerial threats which can be encountered during future wars, make new weapons into third generation ground to air missile weapons systems with good performance--able to satisfy the requirements of key point air defense and field air defense in the future and possessing appropriately advanced natures. The second is to start out from China's actual situation.

Consideration must not only be given to advanced characteristics. The possibilities must also be considered. Only then is it possible to take up an invincible position. New weapons must have both counter aircraft and counter tactical ballistic missile capabilities. At the same time, development of specialized counter tactical ballistic missiles must be begun. Newly developed ground to air missiles should take into consideration the several points below.

(1) Multiple Uses

Due to the proliferation of forms in the development of aircraft and missiles attacking ground targets as well as increases in performance and tactical changes, there is a requirement that ground to air missiles possess high performance and multiple uses. Only when one type of weapons system completes the missions of many past types of weapons systems is it then able to complete its mission--possessing all the combat capabilities associated with high, medium, and low altitudes as well as being able to counter

aircraft and intercept tactical ballistic missiles (or specialized counter tactical ballistic missile weapons systems). They must be interchangeable for use in all three services.

(2) Possession of Comparatively Strong Counter Jamming Capabilities

Due to bad battlefield environments--in particular, the existence of severe electronic jamming--there is a requirement that ground to air missiles be capable of handling an amalgam of reconnaissance, jamming, and destruction--to be able to make war in various types of complicated environments. In modern wars, electronic countermeasures are a focal point of battle. To control electromagnetic domains becomes a key to achieving victory in wars.

Improving weapons systems counter jamming capabilities is an /42 important means of increasing ground to air missile combat effectiveness. Electronic countermeasures associated with ground to air missiles are primarily improving system counter jamming capabilities through the selection of appropriate guidance systems as well as opting for the use of comprehensive radar counter jamming technologies. In terms of guidance systems, it is possible to opt for the use of composite guidance. In the area of counter jamming without radar, it is possible to opt for the use of multiple function phase control array systems (there is also a need to handle multiple targets).

(3) Handling Multiple Targets

In order to make new models of ground to air missiles possess the capability to handle multiple targets, there is a requirement that weapons systems possess an identification friend or foe capability, the capability to do high speed search, acquire, and track multiple targets, as well as the capability to guide a number of missiles to shoot at multiple aerial targets. To this end, it is necessary to opt for the use of many types of measures--for example, opting for the use of multiple function phase control array radars, active homing guidance technology, vertical firing technology, and so on. Opting for the use of multiple function phase control array radar is capable of resolving problems associated with one radar set simultaneously completing the search for, acquisition of, and tracking of multiple targets, and, in conjunction with that, guiding a number of missiles at the same time to fire at multiple aerial targets. This is an effective means of handling multiple targets. Ground to air missiles opt for the use of active homing guidance to be able to make them into "fire and forget" weapons. This is an ideal method to handle multiple targets and to prevent antiradiation missiles attacking the ground equipment. However, the technology required is high. As far as air defense missiles opting for the use of vertical firing is concerned, it is possible to shorten weapons system reaction times, implement all around attacks, and improve firing efficiency.

(4) Good Maneuverability

The high degree of maneuverability associated with ground to

air missile weapons systems is an important factor associated with combat power. It is a necessary condition for defense flexibility and a key area associated with survivability. It is possible to opt for the use of solid state electronic devices as well as solid rocket motors (opting for the use of solid pulse composite motors is also one type of development trend), thus reducing radar and missile volumes and masses. Besides this, vehicles and electric cable connections between vehicles are reduced as much as possible, thereby shortening weapons system set up and take down times--making the entire system possess good maneuverability.

(5) High Levels of Automatization and Short Reaction Times

Air defense missiles must have high levels of automatization and fast reaction capabilities. Only then are they capable of adapting to the requirements of air defense combat. This then requires short weapons system reaction times and automatization of search, detection, identification, tracking, as well as guidance operations. At the same time, test measurement equipment should be

automated, making it capable of automatic monitoring and malfunction indication as well as isolation.

(6) High Reliability

High reliability is capable of increasing missile kill and damage probabilities and extending missile utilization limits. As far as malfunctions associated with ground to air missile weapons systems are concerned, most of them are related to the reliability of electronic equipment components. The application of large scale integrated circuits and microelectronic subassemblies has an important role with regard to increasing reliability.

(7) Low Cost

3.2 Carry Out Improvements on Old Models that Have Prospects for Development. Increase Combat Capabilities, and Satisfy the Requirements Associated with Future Air Defense Combat.

With regard to the ground to air missile models which China currently has, tactical and technical performance is relatively backward. They are not capable of being equal to future air defense combat requirements. As a result, at the same time as efforts are made to develop new models, it is necessary to pay very serious attention to the improvement of old models--laying particular emphasis on strengthening counter jamming capabilities, maneuverability, reducing reaction times, enlarging ranges, and so on. In this way, it will make the difficulties small, development fast, and economize on development time and expenses. This has been verified as an effective method in practice. /43

3.3 Strive to Develop Air Defense Weapons Systems which Combine Missiles and Guns

The development of ground to air missile weapons systems ought to be coordinated with the development of antiaircraft artillery, that is--with a view to the needs of integrated air defense systems--not only make the two compatible, but make ground to air missile weapons systems play their core role in ground air defense combat. In respect to the rational emplacement of ground to air missiles and antiaircraft artillery, air defense weapons systems

which combine missiles and guns are economical and effective measures to resolve low altitude defense and for dealing with multiple targets. Combinations of missiles and guns refer to fire control systems where short range ground to air missiles and small caliber antiaircraft guns are used together and are combined to become a comprehensive antiaircraft system. One fire control system which uses missiles and guns together is capable of gaining the strengths of missiles and guns, and, in conjunction with that, compensating for their respective shortcomings. Within defense zones, short range ground to air missiles are capable of bringing into play the advantages of longer range, higher accuracy, and larger kill and damage probabilities than antiaircraft artillery. Antiaircraft guns are capable of using concentrated firepower in order to kill and damage targets close up. In conjunction with this, they fill in the gaps of missiles at the very shortest ranges as well as acting as fire protection at the instants when missiles are reloaded. The coordination of weapons systems combining missiles and guns is also capable of reducing the influences suffered from electronic jamming as well as the perils of saturation attacks. Due to the fact that they use one fire control system together, it is also possible to lower costs. From now on, efforts should be made to develop this weapons system.